

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Electrode Assembly Pack Adapted for "Zig-zag" Folding

- We, VARTA AKTIENGESELLSCHAFT, Frankfurt/main Neue Mainzer Strasse 54, Germany, a German Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- The invention relates to an electrode assembly pack for accumulators, and particularly for alkaline accumulators. The electrode assembly pack, which is adapted for zig-zag folding consists of a plurality of electrically interconnected, coherent plate chains.
- Electrode assembly packs of this kind are known. In one construction (German Auslegeschrift No. 1,194,471), the plate chains consist of circular plates which are connected at the peripheries along the line of the centres by electrically conductive tongues coated with a layer of insulating varnish. In the finished electrode assembly pack, the folded plates of the first group are disposed between the plates of the second group with individual separator discs provided between the plates.
- The manufacture of the component parts, and particularly the assembly of the electrode pack, is extremely cumbersome and involve time-consuming operations particularly when electrode assembly packs of considerable thickness, which consist of a plurality of positive and negative plates, are to be produced. A substantial number of the individual separators have to be cut to size and have to be placed carefully upon individual plates. The connecting tongues have to be coated with an insulating varnish. When the plates are placed one upon the other, care has to be taken that the plates are exactly superposed. In such constructions, the risk of displacement of the individual layers in the finished cell cannot be avoided.
- It is an object of the invention to provide an electrode assembly pack of a construction,
- in which the disadvantages hereinbefore described are avoided, and the manufacture of the electrode assembly pack is considerably simplified without its quality being affected.
- In the electrode assembly pack according to the invention, the insulation and thus the safety in operation of the accumulator are in general improved. Displacement of the individual component parts of the electrode assembly pack in the finished cell is no longer possible. The invention affords the additional advantage that, with electrode packs of a given shape and composition, the order of succession of the plates may be changed by simple manipulation.
- According to the invention there is provided an electrode assembly pack for accumulators, in which the plates of one polarity, before folding, are in the form of a chain of rectangular plates electrically connected each to the next plate along, or close to, one side of the series of plates by short webs permitting the plates to be folded in a zig-zag manner parallel to each other, the said plates being enclosed before folding by a U-section continuous separator, and the plates of the other polarity being similarly electrically connected along or close to one side of the series and interleaved with the plates of the said one polarity by zig-zag folding of the assembled plates.
- All of the plate chains of the other polarity may contact one arm of the separator, or, with the desired alternation of the plates, may contact the wrapped plate chains on each side.
- Some constructions of the electrode assembly pack according to the invention are diagrammatically illustrated by way of example in Figures 1 to 12 of the accompanying drawings.
- Figures 1 to 3 show the individual component parts of an electrode assembly pack comprising one positive plate chain and one negative plate chain. The plate chains 1 and

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2 of different polarities consist of individual electrode plates which are held together at opposite sides by a conductive flexible tape 4. The tape 4, which may be made of a separate piece, is connected to the individual plates by suitable means. It may have a cross-section the shape of the letter "U" which encloses the plates, or it may be disposed on one side of the plates only. The connecting webs may, however, also be punched out together with the supports for the active mass of the plates. The current conductors 7 are connected to the connecting piece at the desired position. The plate chain 1 is introduced into the space between the arms of the U-section separator tape 3, so that the two arms 5 and 6 of the separator tape enclose the plate group 1 in the manner of the letter "U" the connecting tape being in the mouth of the "U". According to the desired method employed for folding the electrode assembly pack, the plate chain 1 is then either placed against one of the arms of the separator or, as indicated on the right-hand side of Figure 1, is slipped over both arms, so that the individual plates of the electrode chain 2 enclose the two arms of the U-section separator tape in the desired alternation hereinafter described in detail.

Figure 4 shows a finished assembled electrode pack with slight zig-zag-folding. In this construction, every second plate in the plate chain 2 is disposed on the opposite side of the separator tape.

Figure 5 shows the finished folded electrode pack.

Figure 6 shows two plate chains, in which the connecting webs are disposed on opposite sides close to the ends of the plates.

Various constructions, in which the connect-

ing webs are provided eccentrically have produced good results in practice. The connecting webs need not necessarily be disposed on opposite sides of the electrode assembly. In the construction shown in Figure 7, the connections of both plate chains are disposed on the same side of the electrode assembly pack.

In addition to the extremely simple manufacture and the aforementioned good properties, such as good insulation and resistance to displacement, of the electrode assembly pack according to the invention, the order of succession of the plates in the electrode assembly pack can be varied by simple means. The possibility of changing the order of succession of the plates by simple means is of importance in cells of many types. In gas-tight alkaline accumulators, for example, the capacitance and the rate of charge of negative electrodes at the moment of sealing exceed those of the positive electrodes. The negative electrodes are divided into two part-electrodes in order to ensure an improved consumption of the oxygen evolved at the positive electrode upon charging. The effect of such negative double electrodes may also be obtained by simple means by the electrode assembly pack according to the invention after suitable assembly and folding.

Some constructions of the electrode assembly pack according to the invention are described with reference to Figures 8 to 12. An electrode assembly pack containing octopartite positive plate chains and octopartite negative plate chains and, in some cases, heptapartite positive plate chains, may serve as an example.

Thus, for example, the following succession of electrodes

+ - - + + - - + + - - + + - - +

is obtained when a positive plate chain and a negative plate chain are placed side by side, that is to say, when the complete plate chain are placed side by side, that is to say, when the complete plate chain not enclosed by the separator tape is disposed on the outside of one of the arms of the separator and is then subject to zig-zag-folding.

Folding in the opposite directions results in the same succession of the electrodes, except that the series starts and terminates with a negative electrode. The electrode assembly pack so folded may be folded over in the middle by reversing the sense of folding of a fold in the middle of the pack without the order of succession of the electrodes being changed. After the pack has been so folded over in the middle, the external electrode plates of the same polarity are disposed side by side and form the central double electrode at that position. This construction affords the advantage that the plates, now disposed on the

outside, are already held together on one side by a web, and on the other side the webs are slightly pinned together so that the assembly pack cannot spring apart. It is now unnecessary for the electrode to be wrapped with tape as otherwise necessary in such cases. When a plurality of electrode plates is provided, the web between the two plates in the middle has to be longer, since it interconnects the two external plates when the pack is folded over and thus has to bridge the whole thickness of the electrode assembly pack.

In an alternative construction, the web between the first and the second plate or the web between the penultimate and the last plate may be lengthened, and, after completed zig-zag-folding, the first or the last electrode group may be folded over so that it comes to lie on the other side of the electrode assembly pack. The order of succession of the electrodes is then as follows:—

— + + — — + + — — + + — — + + —

comprising two negative double electrodes and one positive double electrode. In this drawing and in the subsequent drawings, the negative plate chains are light and the positive plate chains dark for the sake of convenient surveyance. The positive and the negative plate chains are intercalated by slots 8, 9, 10 and 11, and are then zig-zag-folded. When the first electrode is a positive plate, the order of succession of the electrodes is as follows:—

Figure 8 shows an electrode assembly pack

$+$ $-$ $+$ $-$ $-$ $+$ $-$ $+$ $+$ $-$ $+$ $-$ $-$ $+$ $-$ $+$

positive double electrode. The negative plate chain comprises eight plates, and the positive plate chain seven plates. The two chains are intercalated so that the end plate 12 of the negative chain remains standing by itself. The chains are intercalated by slots 13, 14 and 15. The electrode assembly pack is then obtained by zig-zag-folding. The isolated negative electrode 12 is folded into the positive double electrode between the slots 14 and 15. The order of succession of the electrodes is then as follows:—

35 Figure 9 shows an electrode assembly pack with two negative double electrodes and no

$$+ - + - - + - + - + - - +$$

50 The electrode pack illustrated in Figure 10 also comprises one octopartite negative plate chain and one heptapartite positive plate chain. The two chains are intercalated by the slots 16, 17 and 18. After completed zig-zag-

folding, the exposed negative electrode is introduced into the positive double electrode after the slot 17. The order of succession of the electrodes is:—

$$+ - + - - + - + - - + - +$$

60 The effect of double negatives without
double positives in symmetrical arrangement
may be obtained by placing two negative plate
chains, preferably of half the thickness of the
positive plate chain, one upon the other with
65 or without an intermediate spacer, for ex-
ample made of expanded metal or metal mesh.

and by intercalating them with the positive plate chain illustrated in Figure 4, so that, upon zig-zag-folding, each positive electrode is flanked by two negative electrodes. The order of succession in an octapartite electrode assembly pack is as follows:—

- - + - - + - - + - - + - - + - - + - - +

75 In Figure 11, two negative plate chains are provided in staggered relation, so that one negative plate is disposed at each end. As indicated in Figure 4, the negative electrode

chains are intercalated with the positive electrode chain, so that the order of succession of the electrode after completed zig-zag-folding is as follows:— 80

$- + - - + - - + - - + - - + -$

85 One of the simplest methods of obtaining double negative electrodes without double positive electrodes is to place a wrapped positive plate chain between two negative plate chains without the plate chains being intercalated.

The plates of the plate chains have to overlap exactly. By zig-zag-folding, an electrode assembly pack of the following construction 90 is obtained:—

- + - - + - - + - - + - - + - -

Figure 12 shows an electrode assembly pack of this kind which comprises two negative and one positive plate chain which, for the sake of convenient surveyance, are provided at staggered levels.

WHAT WE CLAIM IS:—

1. Electrode assembly pack for accumulators, in which the plates of one polarity, before folding, are in the form of a chain of rectangular plates electrically connected each to the next plate along, or close to, one side of the series of plates by short webs permitting the plates to be folded in a zig-zag manner parallel to each other, the said plates being enclosed before folding by a U-section continuous separator, and the plates of the other polarity being similarly electrically connected along or close to one side of the series and interleaved with the plates of the said one polarity by zig-zag folding of the assembled plates.
2. Electrode assembly pack according to claim 1, in which all of the plates of the plate chain of the other polarity contact one arm of the separator.
3. Electrode assembly pack according to claim 1, in which the plate chain of the other polarity contacts the wrapped plate chain on both sides of the plates in the alternation desired.
4. Electrode assembly pack according to any of claims 1 to 3, in which the plate chains are provided at vertically staggered levels, whereby parts of each electrode plate have no counter-electrode.
5. Electrode assembly pack according to any of claims 1, 2 or 4, comprising one negative and one positive plate chain, the whole unwrapped plate chain contacting one arm of the separator, and both plate chains being zig-zag-folded.
6. Electrode assembly pack according to claim 5, in which the central fold or a fold near to the middle of the pack is refolded in

the reverse sense, whereby the electrode plates originally at the ends of the pack are brought together in the middle or near to the middle of the pack.

7. Electrode assembly pack according to any of claims 1, 3 or 4, comprising one negative plate chain and one positive plate chain, the plates of the unwrapped electrode chain contacting alternately one and the other arm of the U-section separator.

8. Electrode assembly pack according to any of claims 1, 3 or 4, consisting of one negative and one positive plate chain, successive pairs of plates of the unwrapped plate chain contacting alternately one and the other arm of the separator tape.

9. Electrode assembly pack according to any of claims 1 to 4, in which the plate chain of one polarity has an additional plate at one end, having no corresponding plate of the other polarity, which is folded back into one of the folds of the electrode assembly pack.

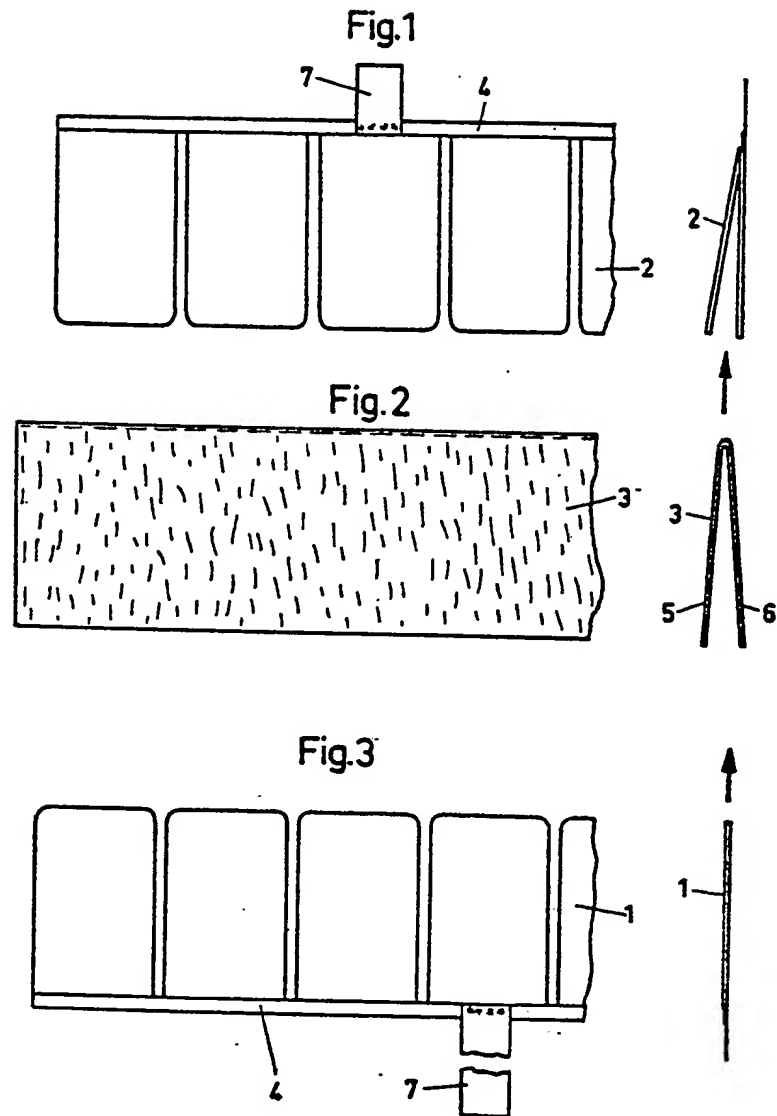
10. Electrode assembly pack according to any of claims 1, 3 or 4, which consists of one positive plate chain and two negative plate chains the negative plate chains, with or without a spacer between them, being disposed side by side, and the pairs of negative electrodes thus obtained being disposed on both sides of the positive plate chain of plates wrapped with the separator, in the alternation desired.

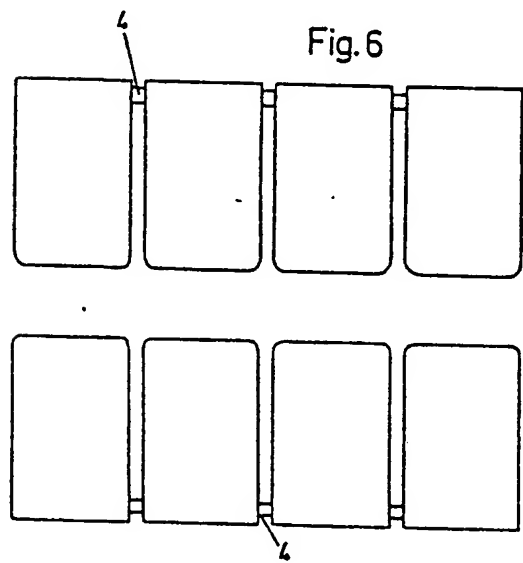
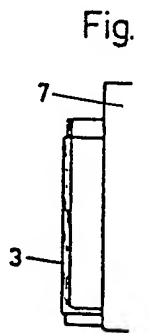
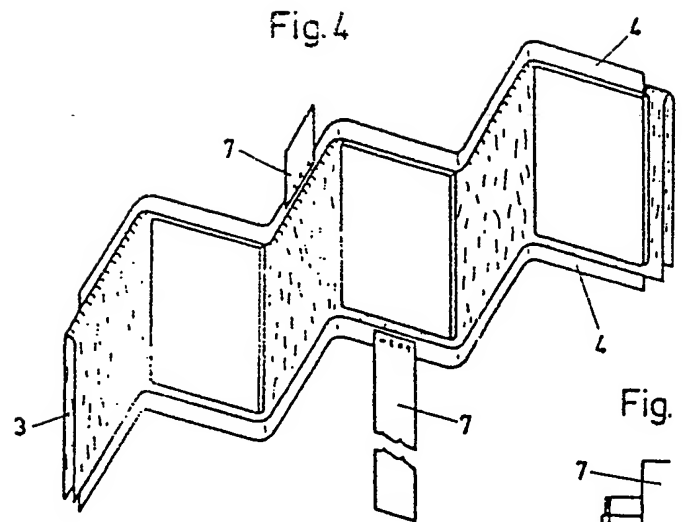
11. Electrode assembly pack according to any of claims 1, 2 or 4, in which the wrapped positive plate chain is surrounded by two negative plate chains, each group contacting one of the arms of the separator tape, and the plate chains being zig-zag folded.

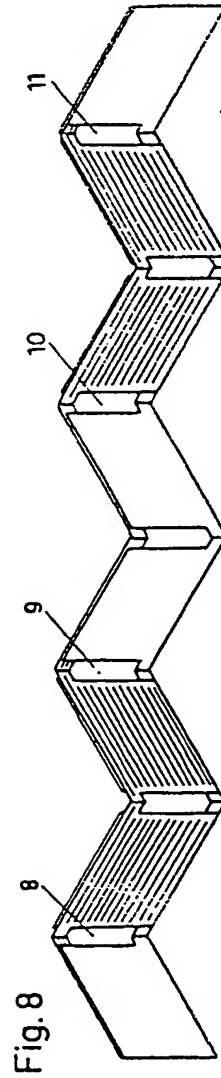
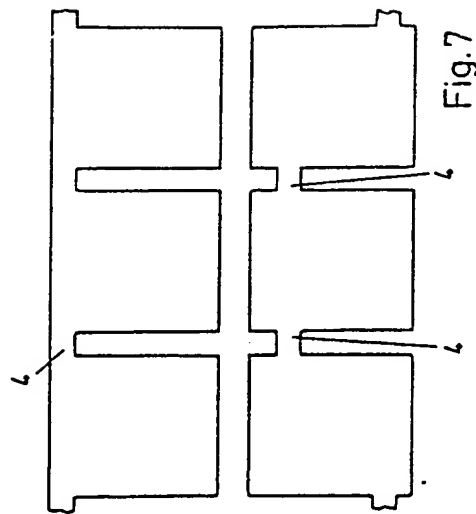
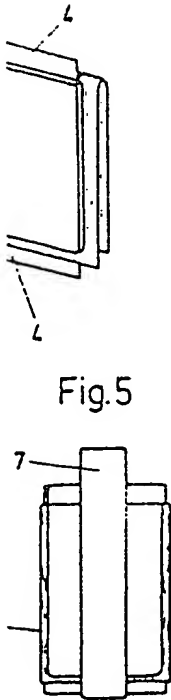
12. Electrode assembly pack, substantially as hereinbefore described and illustrated in the accompanying drawings.

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Agents for the Applicants.

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Sheets 2 & 3

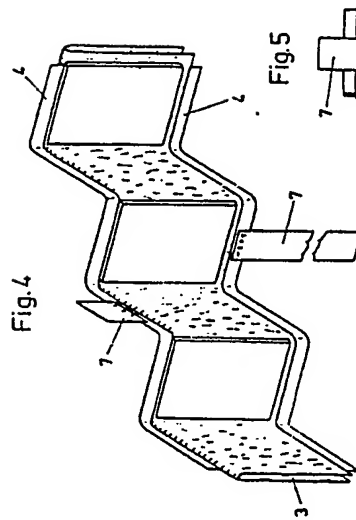


Fig. 5

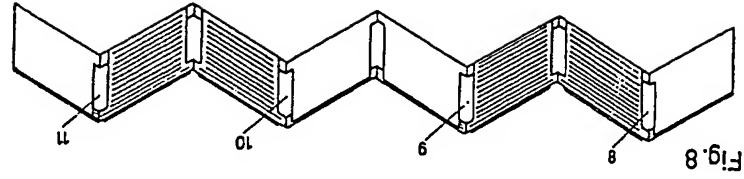
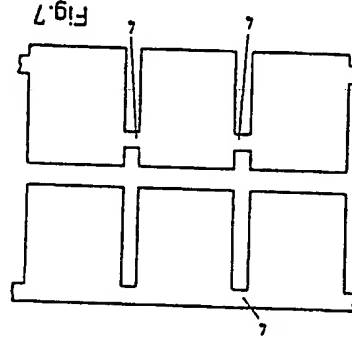
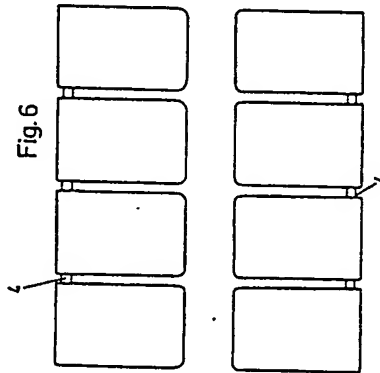
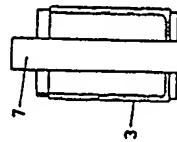


Fig. 9

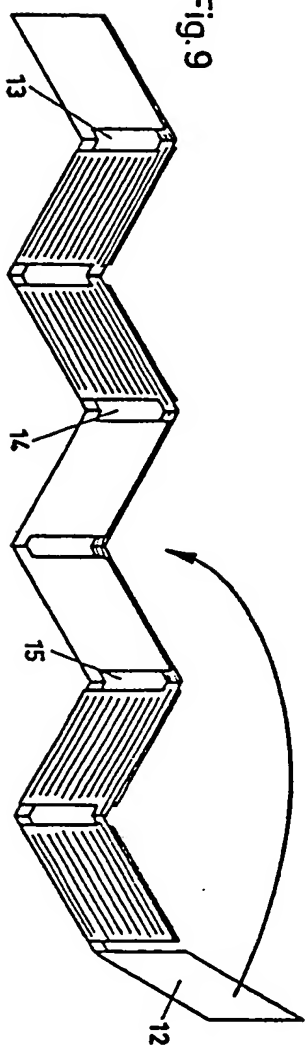
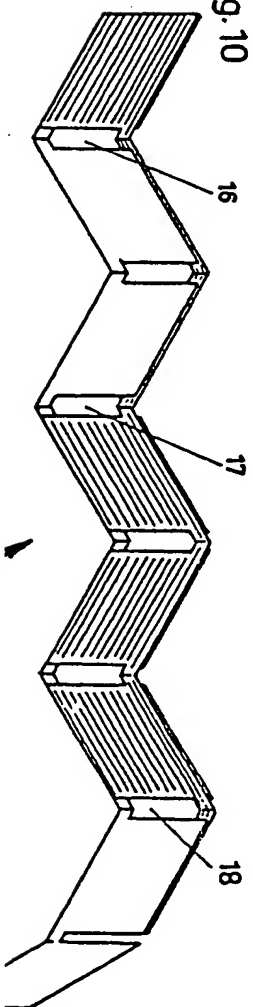


Fig. 10



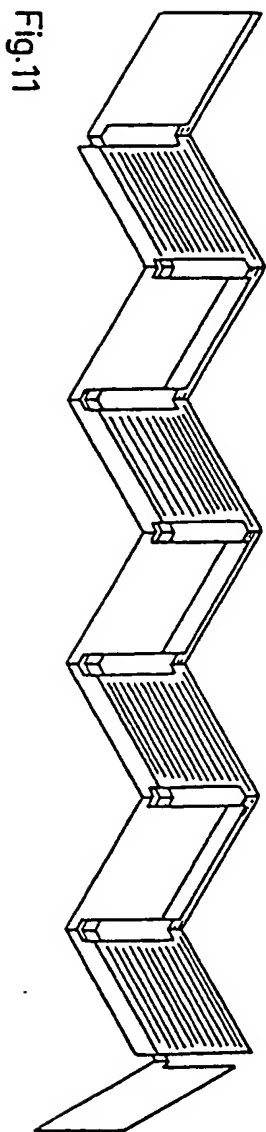
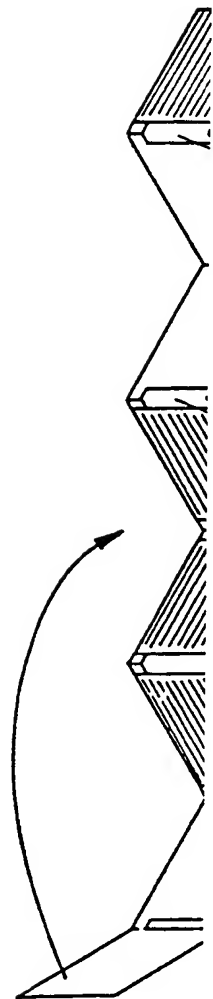


Fig. 11

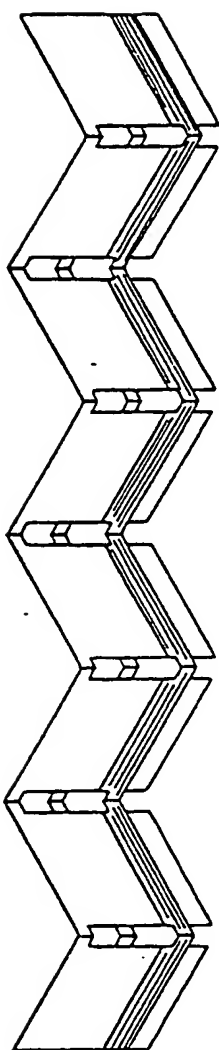


Fig. 12

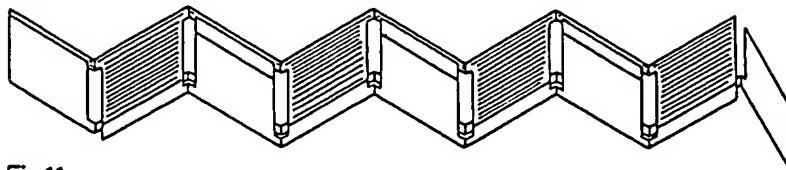
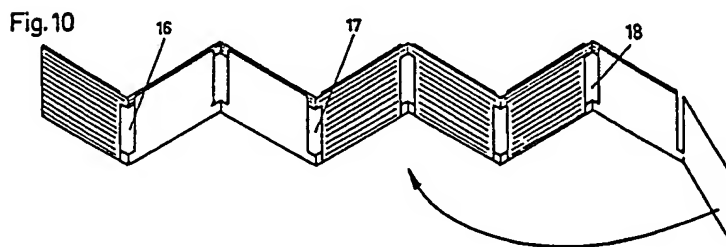
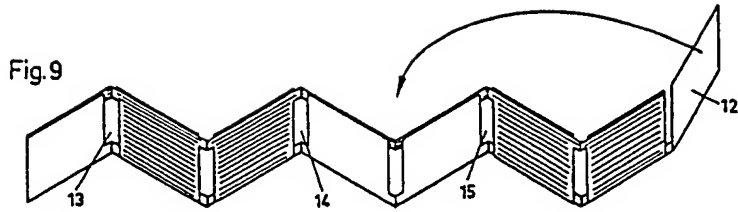


Fig.11

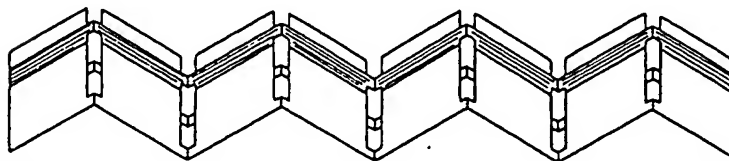


Fig.12

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